UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
Intermountain Forest and Range Experiment Station
REED W. BAILEY, DIRECTOR
Ogden, Utah May 1956

PLANS FOR THE TECHNICAL DIRECTION OF THE 1956 SPRUCE BUDWORM CONTROL PROJECT IN WESTERN MONTANA AND NORTHERN IDAHO

By David McComb, Entomologist

Prepared By The
Missoula Forest Insect Laboratory
Missoula, Montana

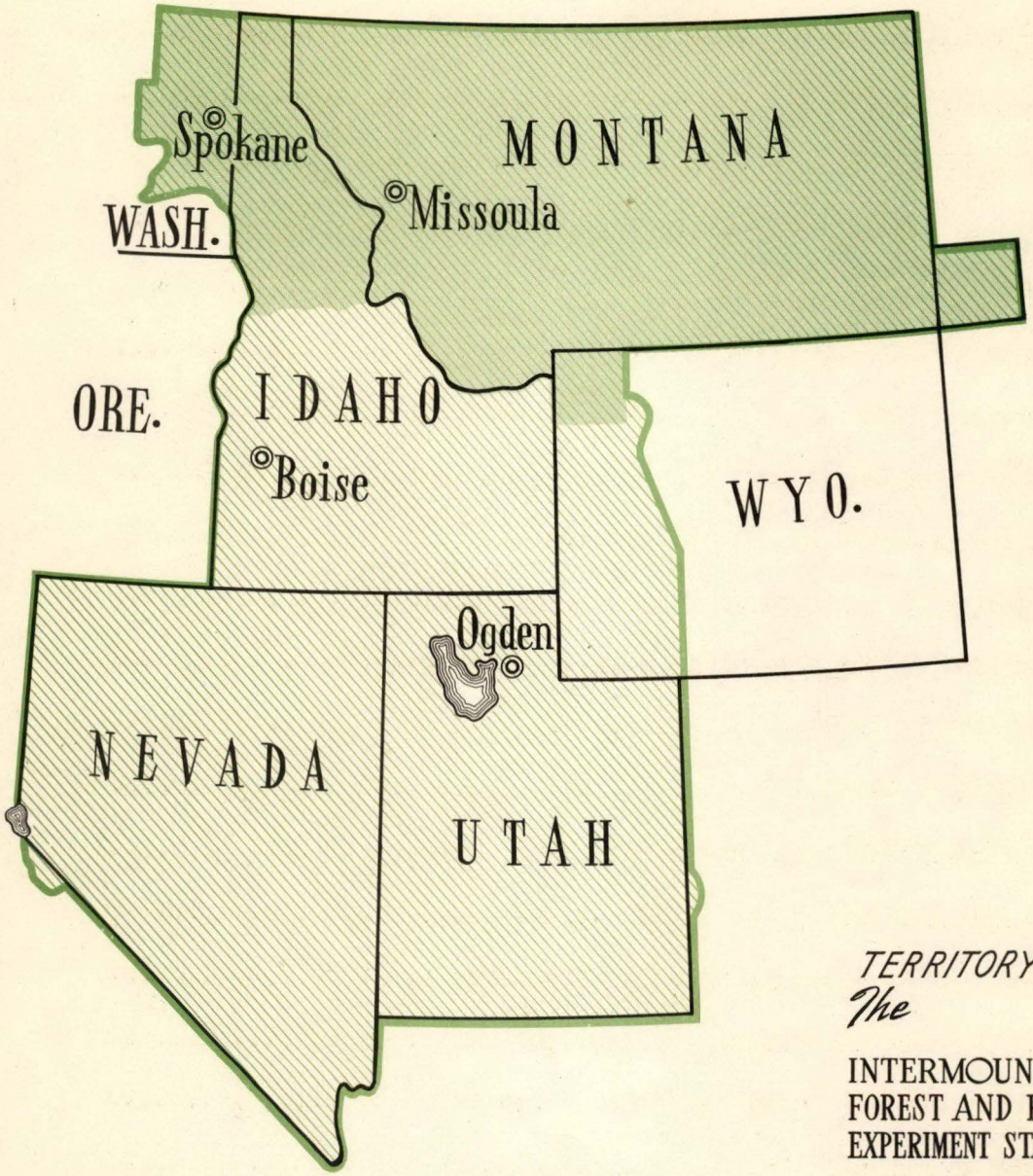
UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
Intermountain Forest and Range Experiment Station
REED W. BAILEY, DIRECTOR
Ogden, Utah May 1956

PLANS FOR THE TECHNICAL DIRECTION OF THE 1956 SPRUCE BUDWORM CONTROL PROJECT IN WESTERN MONTANA AND NORTHERN IDAHO

By David McComb, Entomologist

Prepared By The
Missoula Forest Insect Laboratory
Missoula, Montana

The AREA COVERED BY THIS REPORT



TERRITORY OF
The
INTERMOUNTAIN FOREST AND RANGE EXPERIMENT STATION

The MISSOULA FOREST INSECT LABORATORY is a field unit of the Intermountain Forest and Range Experiment Station at Ogden, Utah. The Laboratory conducts forest insect research, surveys forest insect outbreaks, and gives technical advice on cooperative insect control programs in Montana, northwestern South Dakota, northwestern Wyoming, northern Idaho, and northeastern Washington.

The functions are conducted in the remaining station territory by staff entomologists at Ogden, and Boise, Idaho.

TABLE OF CONTENTS

PLANS FOR THE TECHNICAL DIRECTION OF THE 1956 SPRUCE BUDWORM CONTROL PROJECT IN WESTERN MONTANA AND NORTHERN IDAHO

INTRODUCTION

The epidemic outbreak of spruce budworm, Choristoneura fumiferana (Clem.), now current in western Montana and northern Idaho has spread in extent and severity of resultant tree damage each year since its origin in 1948. Aerial and follow-up ground surveys by the Laboratory in 1955 showed that the infestation now is estimated to cover 3,100,000 acres.1/

Control measures in 1955 were applied to four areas having a total of 372,652 acres. Because satisfactory budworm mortality was recorded in these areas following the control action, they are not included in the 1955-infested acreage.

Douglas-fir has been the tree species mostly affected by the outbreak, but true firs and Engelmann spruce have also been attacked by this insect. Considerable tree mortality, mostly in the immature fir growing stock, has resulted from the successive annual feeding of the budworm caterpillars, appreciable loss in tree increment has occurred in all age classes of host trees, and some subsequent killing by the Douglas-fir beetle has followed budworm defoliation of mature trees in several infested areas.

The spread of the outbreak has not been without setbacks: since 1950 natural control has occurred in two rather large areas of the Flathead National Forest and aerial spraying has brought control in others.

With the expansion of the current spruce budworm outbreak there has also been a change in the intensity of defoliation. In areas where the infestation has persisted for several years, defoliation has, in many instances, increased from light to moderate or from moderate to heavy. As a consequence, the damage per acre of infestation has been greater.

1/ TERRELL, TOM T. Spruce budworm infestations in the northern Rocky Mountain region, 1955. Missoula Forest Insect Laboratory, Intermountain Forest and Range Experiment Station, Missoula, Montana. January 25, 1956.

Plans by the Forest Service, Region One, to control the budworm infestations on a project basis[2] in 1956 by the aerial spraying of DDT insecticide have been made to cover approximately 810,000 acres in the following control units:

1.	White Sulphur Springs Unit,	
	Lewis and Clark National Forest, Montana	300,000 acres
2.	Powell-Bitterroot Unit,	
	Lolo National Forest, Idaho	100,000 acres
	Bitterroot National Forest, Montana	32,000 acres
3.	Madison-Tobacco Root Unit,	
	Beaverhead National Forest, Montana	150,000 acres
4.	Pioneer Unit,	
	Beaverhead National Forest, Montana	138,000 acres
5.	Elkhorn-Crow Creek Unit,	
	Helena National Forest, Montana	70,000 acres
	Deerlodge National Forest, Montana	20,000 acres

The following plans by the Intermountain Forest and Range Experiment Station for the technical direction of the 1956 western Montana-northern Idaho budworm control project are patterned after similar plans prepared for the 1955 budworm spray project,[3] with several modifications.

RESPONSIBILITIES OF THE INTERMOUNTAIN STATION

The Intermountain Forest and Range Experiment Station has been charged by the Chief of the Forest Service with the technical direction of the 1956 western Montana-northern Idaho spruce budworm control project under provisions of his memorandum O No. 55-17 of February 15, 1955 (O-ORGANIZATION - General). Under these provisions, the Intermountain Station is responsible for the following technical services connected with the project:

2/ In cooperation with the Montana State Forestry Department, Idaho State Forestry Department, the U. S. Bureau of Land Management, and the Northern Pacific Railway Company.

3/ JOHNSON, PHILIP C. Plans for the technical direction of the 1955 spruce budworm control project in western Montana and northern Idaho. Forest Insect Laboratory, Intermountain Forest and Range Experiment Station, Missoula, Montana. May 1, 1955.

1. Project planning.--In collaboration with the Regional Forester, Forest Service Region One, to recommend the methods, materials, and timing of operations for controlling the current spruce budworm infestation.

2. Project area delineation.--To conduct surveys within the project area, if needed, to locate and designate the trees or areas to be treated. The Station will conduct needed technical training programs and will make inspections of the technical phases of the project.

3. Determine control effectiveness.--To conduct post-control checks in project areas to determine the effectiveness of the control effort and the need for additional control within the project area; prepare reports on the entomological aspects of the control project.

On-the-ground supervision of the above-mentioned technical aspects of the project has been delegated by the Director of the Intermountain Station to the Missoula Forest Insect Laboratory. Although the Intermountain Station is charged with specific responsibilities in connection with the spruce budworm control project, it is essential that Station personnel cooperate and work with personnel of Forest Service Region One to facilitate coordination of the technical and administrative phases of the project.

To carry out the technical supervision responsibilities of the Station, the Missoula Forest Insect Laboratory will provide the following technical services for the budworm control project:

1. Checking 1955-56 overwintering budworm population densities from representative locations within the control units.

2. Determining, with Forest Service Region One, the final control boundaries.

3. Recommending the insecticide formulation to be used.

4. Recommending the proper method for the application of the insecticide.

5. Timing the sequence of spraying operations.

6. Checking the adequacy of insecticide deposition.

7. Determing pre- and post-spray budworm population densities for the purpose of calculating budworm mortality attributable to the spraying operation.

8. Supervising post-control surveys to establish firm infested acreage estimates of remaining unsprayed areas in the region.

9. Aiding the Regional Forester, Forest Service Region One, through his delegated Control Project Director, is presenting the technical aspects of the project to the public, the national forest administration personnel assigned to the project, and to other individuals and agencies cooperating in the control effort.

TECHNICAL ORGANIZATION

An organization planned to carry out the technical supervision of the project is shown in table 1.

ENTOMOLOGIST-IN-CHARGE

Philip C. Johnson, Leader, Forest Insect Laboratory, Missoula, Montana has been designated Entomologist-in-Charge by, and will be responsible to, Director Reed W. Bailey, Intermountain Forest and Range Experiment Station, Ogden, Utah, for the supervision of all technical phases of the project.

TECHNICAL DIRECTOR

David McComb, Entomologist, Forest Insect Laboratory, Missoula, Montana, will be Project Technical Director with full responsibility for the field direction of technical phases. Being responsible to the Entomologist-in-Charge, his primary duties will be:

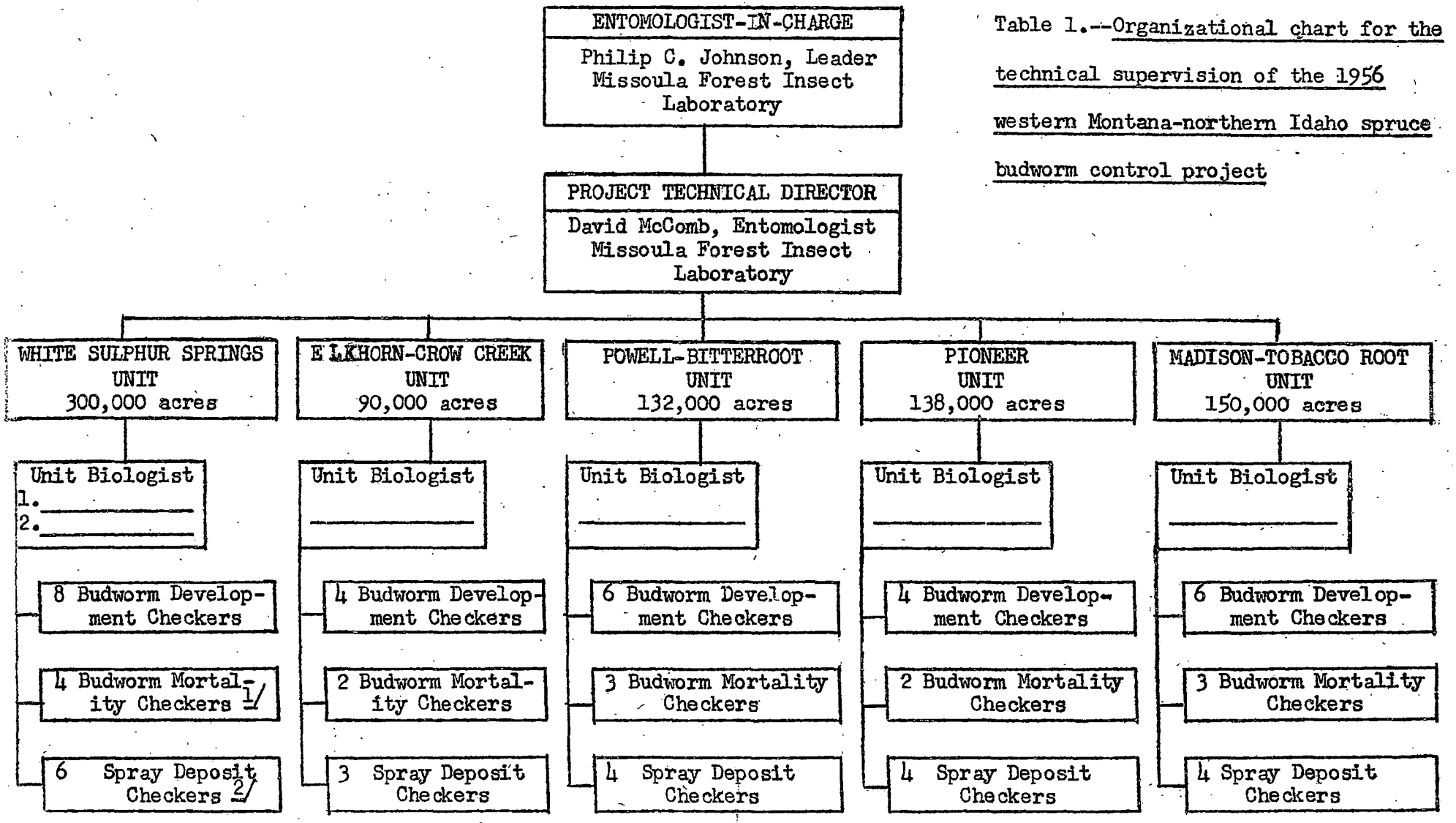
1. To assist the Project Director in the preparation of administrative plans to the extent that technical requirements for effective control will be integrated.

2. With the Project Director, to serve as a liaison between administrative and technical functions of the project.

3. To train and be responsible for the performance of the Unit Biologists.

4. To assist the Unit Biologist in planning and conducting the training programs for the Budworm Development Checkers.

Table 1.--Organizational chart for the technical supervision of the 1956 western Montana-northern Idaho spruce budworm control project



1/ One-half the development checkers will be transferred to Mortality Checking when spraying is started

2/ SPRAY DEPOSIT CHECKERS: 1 for each Multi-engine aircraft
1 for every two single-engine aircraft

Table 2.--Organization chart for the technical direction of the White Sulphur Springs control unit

Unit Supervisor: Geo.A.Mahrt
Field Office: _____
Airfield: White Sulphur Sps.
Acres: 300,000
No. Planes: 4

ENTOMOLOGIST-IN-CHARGE
Philip C. Johnson

TECHNICAL DIRECTOR
David McComb

WHITE SULPHUR SPRINGS West Half Unit Biologist	WHITE SULPHUR SPRINGS East Half Unit Biologist
_____	_____
4 BUDWORM DEVELOPMENT CHECKERS 1. _____ 2. _____ 3. _____ 4. _____	4 BUDWORM DEVELOPMENT CHECKERS 1. _____ 2. _____ 3. _____ 4. _____
2 BUDWORM MORTALITY CHECKERS 1. _____ 2. _____	2 BUDWORM MORTALITY CHECKERS 1. _____ 2. _____
3 SPRAY DEPOSIT CHECKERS 1. _____ 2. _____ 3. _____	3 SPRAY DEPOSIT CHECKERS 1. _____ 2. _____ 3. _____

Table 3.--Organization chart for the technical direction of the Powell-Bitterroot control unit

Unit Supervisor: Andy Arvish

Field Office: Powell R.S.

Airfield: Missoula

Acres: 132,000

No. Planes: 2

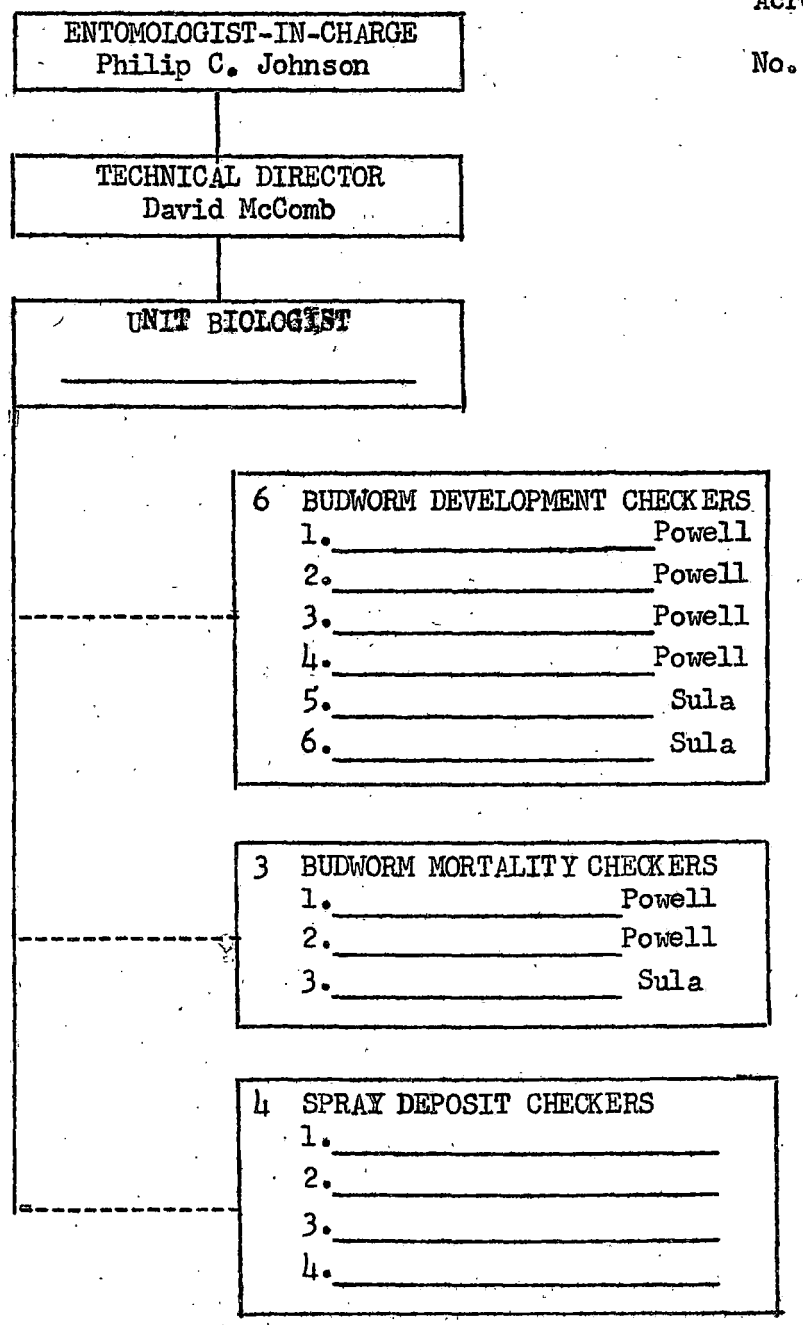


Table 4.--Organization chart for the technical direction of the Pioneer control unit

Unit Supervisor: Frank Bailey

Field Office: Dillon

Airfield: Dillon

Acres: 138,000

No. Planes: 2

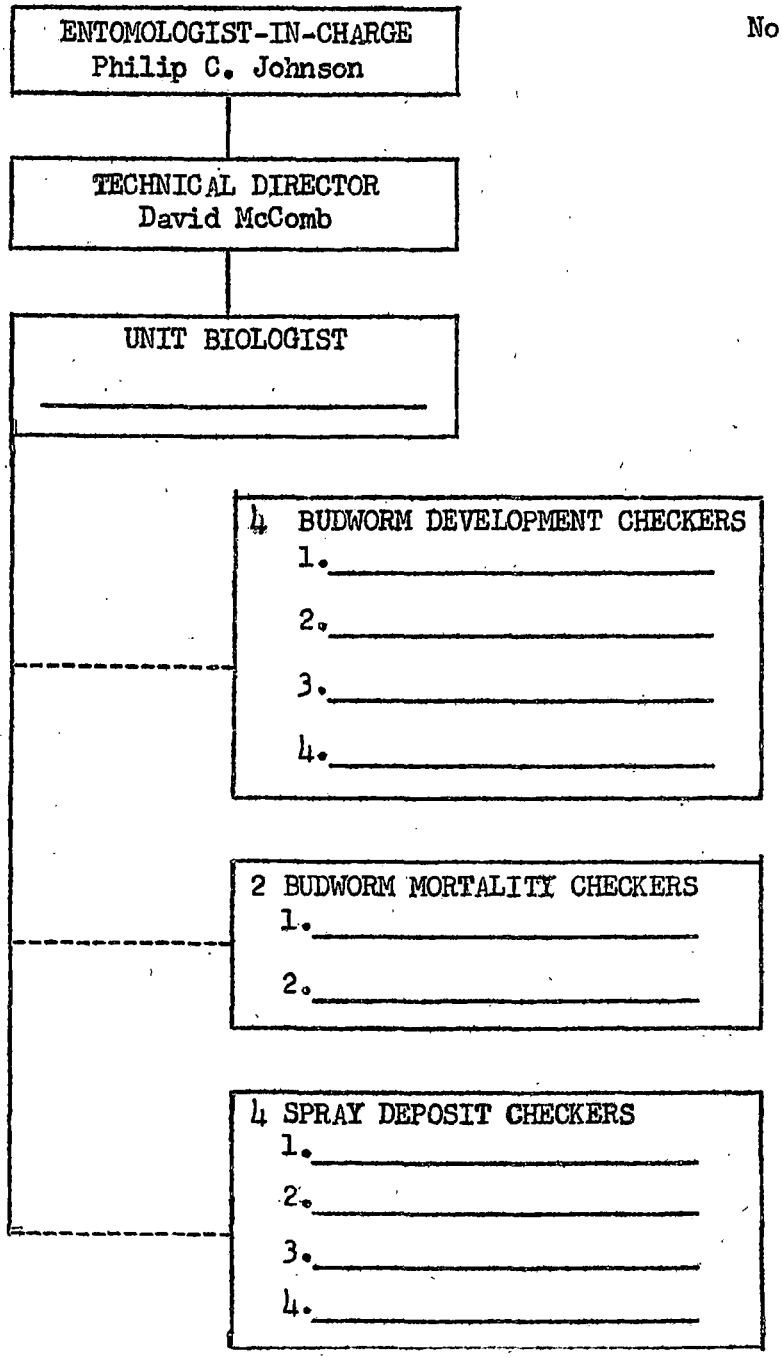


Table 5.--Organization chart for the technical direction of the Madison-Tobacco Root control unit

Unit Supervisor: Frank Bailey

Field Office: Ennis

Airfield: Ennis

Acres: 150,000

No. Planes: 2

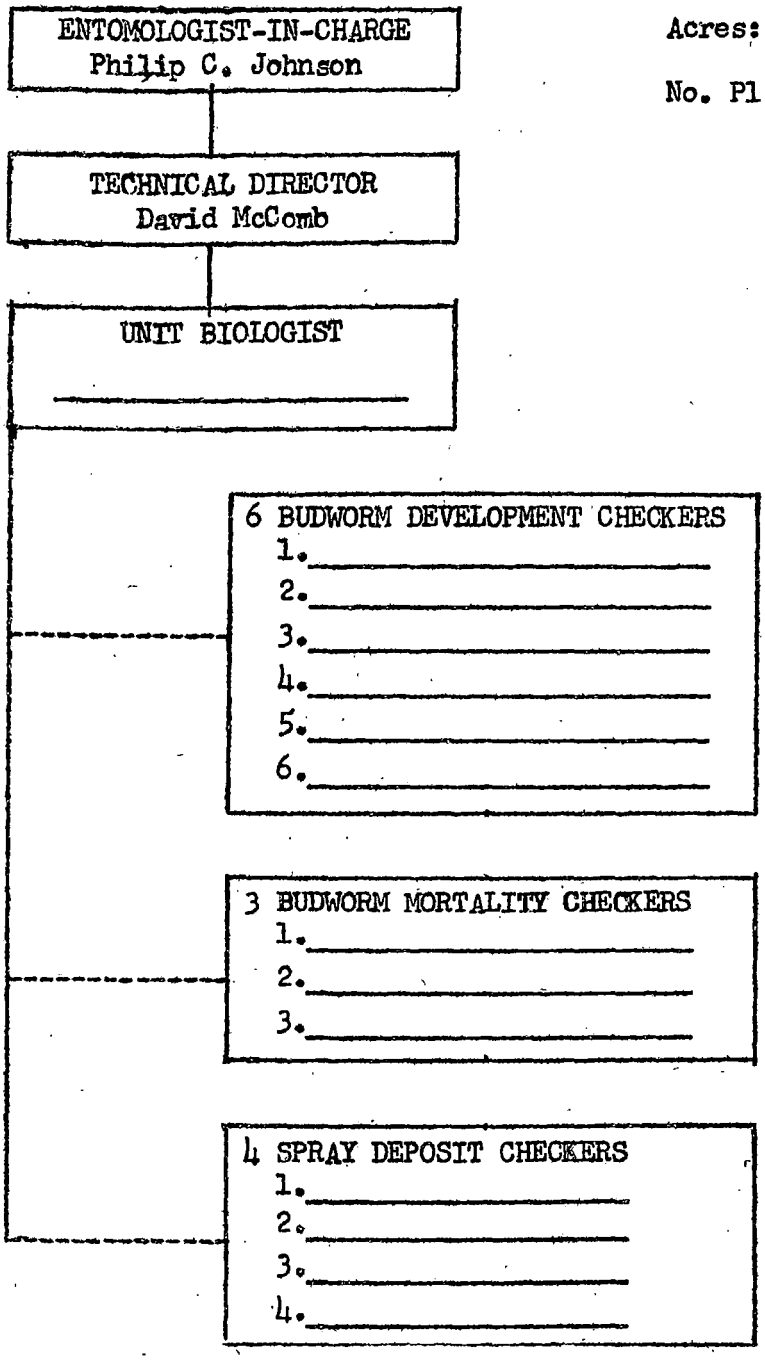


Table 6.--Organization chart for the technical direction of the Elkhorn-Crow Creek control unit

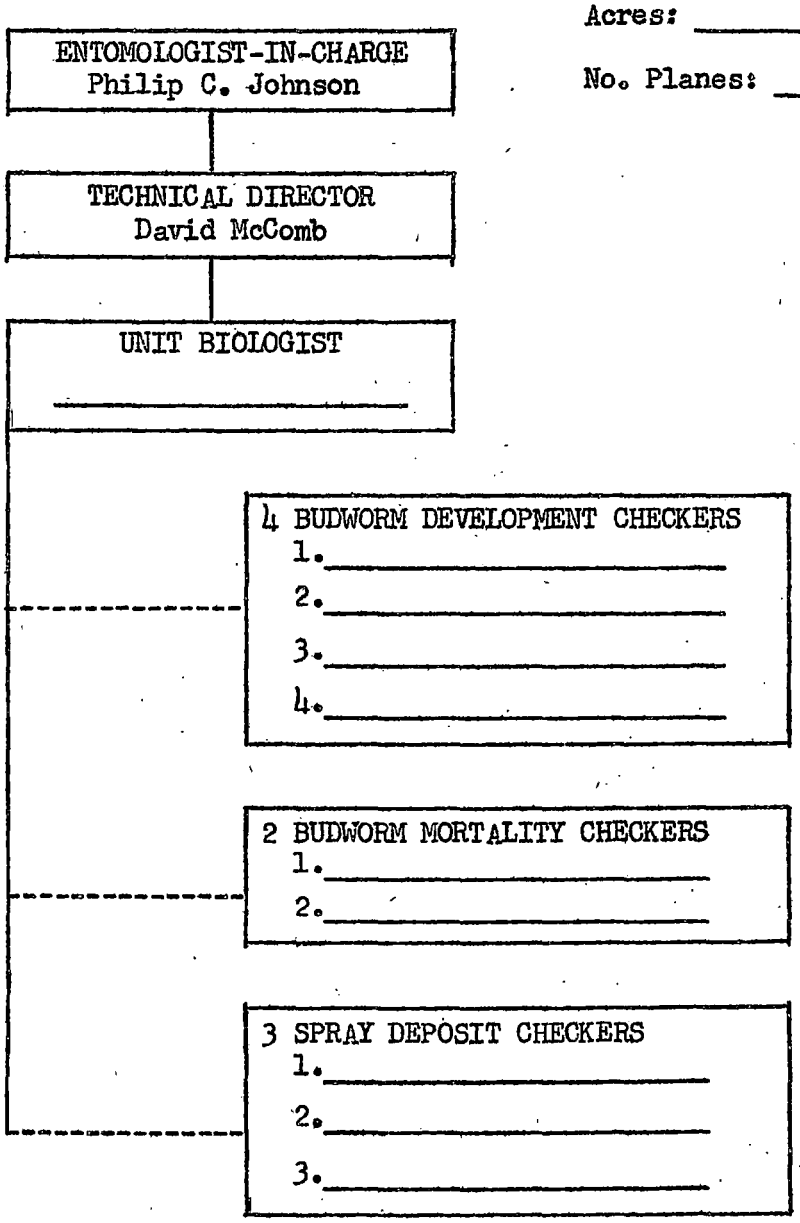
Unit Supervisor: John Milodragovich

Field Office: _____

Airfield: Helena

Acres: 90,000

No. Planes: 2



5. To indoctrinate new Station employees, directly or through the Unit Biologists, into Station fiscal, operational, and safety procedures.

6. To receive from and interpret with the Unit Biologist biological information pertaining to the timing and sequence of aerial spraying, the adequacy of spray deposit in spray blocks, and the budworm mortality achieved by the project.

7. To notify the Project Director of the timing of the initial aerial spraying on each control unit; first notice to be 10 days in advance of the estimated beginning of spray application, further notification as necessary to establish actual start of spraying.

8. To advise the Project Director on technical questions that may arise during the life of the project.

9. To keep the Entomologist-in-Charge and Project Director informed of the technical progress of the project.

UNIT BIOLOGIST

A Unit Biologist, to be detailed from National Forest Administration to the Station, will be assigned to each unit of the control project. He will supervise the technical observations and collections made on his unit and will be directly responsible to the Technical Director for all technical phases and to the Unit Supervisor for Administrative functions. The duties of the Unit Biologist:

1. To become thoroughly familiar with his unit: including roads, trails, elevational zones, boundaries of the unit, spray block boundaries, etc.

2. To instruct the Budworm Development Checkers in the methods of making daily collections of larval material.

3. To select the locations for the daily collections of larval material by the Budworm Development Checkers.

4. To supervise these checkers in their determining of the rate of larval development by measurements of head capsules of the larvae or other approved methods as instructed.

5. To keep detailed records of the progress of larval development from regular collecting plots and other sampling spots located on his unit.

6. To secure larval development data in doubtful blocks as a supplement to data collected at regular collecting plots.

7. To report to the Technical Director on a weekly schedule as to rate of larval development.

8. To collaborate with the Technical Director in interpreting the rate of larval development to determine the timing and sequence of spraying of each unit.

9. To notify the Project Director, Technical Director and Unit Supervisor one or two days in advance of the release of the unit blocks for spraying.

10. To establish lines for the placing of spray deposit checks in each block to sample the spray coverage.

11. To supervise Spray Deposit Checkers who will arrange for spray deposit checking before spraying and collect the resultant measurements after the area has been sprayed.

12. To determine from the spray deposit checks the adequacy of spray deposit in each block.

13. To establish lines for sampling mortality of larval populations before and after spraying and to supervise Budworm Mortality Checkers who will make the counts on these lines.

14. To keep detailed records on the population counts from each mortality line, for pre-spray counts and for post-spray counts.

15. To see that all duties performed by men under his supervision are carried out in a safe manner.

16. To be responsible for time records, government meal records, reimbursement accounts, motor vehicle and property records of subordinate personnel.

17. To be responsible for the proper care and maintenance of motor vehicles assigned to project personnel employed or supervised by the Station.

BUDWORM DEVELOPMENT CHECKERS

One Budworm Development Checker for each 25 to 35 thousand acres of a control unit will be detailed to the Intermountain Station by Forest Service, Region One. Each checker will be directly responsible to his respective Unit Biologist for primary duties as follows:

1. To become thoroughly familiar with the control unit's roads, trails, elevational zones, unit boundaries, block boundaries, etc.

2. Prior to the spraying of a unit, to make daily collections of budworm larvae and observations on the development of foliage at designated points as instructed by the Unit Biologist.

3. To preserve all larvae collected and to examine such collections under the supervision of the Unit Biologist.

4. To keep an accurate record of larvae collected and to turn such records over to the Unit Biologist daily.

5. Prior to and during the spraying of a unit, to make observations and larval collections to determine if the larvae are developing beyond the 5th instar.

6. To properly mark on the ground and on ½-inch unit maps the location from which all field collections are made.

7. To perform all duties as required, in a safe and sane manner.

BUDWORM MORTALITY CHECKERS

When a control unit has been released for spraying, approximately one-half of the Budworm Development Checkers will be re-assigned by the Station as Budworm Mortality Checkers. In this new capacity they will remain directly responsible to their respective Unit Biologists. Their primary duties will be as follows:

1. One or two days before a block is to be sprayed a check of larval population will be made at several stations within the block. (See Mortality Checking Procedure, page 25).

2. An accurate record of such counts will be kept and turned over to the Unit Biologist.

3. A record will be maintained on the ground and on ½-inch unit maps of all stations from which field collections are made.

4. From 7 to 10 days after these stations have been sprayed the budworm population counts will again be taken and the records turned over to the Unit Biologist.

5. Will perform all assigned duties in a safe and sane manner.

SPRAY DEPOSIT CHECKERS

During the period that spraying is done personnel will be detailed by Forest Service Region One to serve as Spray Deposit Checkers. These checkers will be under the supervision of the Unit Biologists. One Spray Deposit Checker will be assigned to each aircraft of 400-gallon spray capacity or more and one checker for every two aircraft of lesser capacity. The duties of these checkers will be as follows:

1. Spray deposit cards will be placed at intervals along a designated course one or two days in advance of the spraying of a block.

2. The cards will be collected within 48 hours after an area has been sprayed.

3. Observations will be made for spray deposit on foliage surrounding cards showing light deposits, and, if necessary, preliminary evidence of larval mortality will be collected.

4. All cards will be numbered and their location recorded on a ½-inch scale map of the unit.

5. Collected spray cards and other evidence of spray deposit will be delivered by each checker to the Unit Biologist.

6. Each Checker will assist the Unit Biologist in determining the extent of the area missed by spray of the need for respraying, or of areas receiving too much spray.

7. Will perform all duties as required, in a safe and sane manner.

INSECTICIDE FORMULATION AND APPLICATION

The insecticide to be used on the 1956 budworm control project shall consist of a solution containing 1 pound of technical grade DDT disolved in 1.25 quarts of auxiliary solvent and sufficient fuel oil to make one gallon of solution at 60 degrees F.

Arrangements will be made to have Dr. W. E. Westlake, Chemist, Division of Insecticide Investigations, Agricultural Research Service, Yakima, Washington, test the ingredients to be used in formulating the insecticide, and to test samples of each batch of insecticide to insure compliance with contract specifications.

Application of the insecticide should be from aircraft flying at an elevation of 100 to 400 feet above the tree tops. Spray should be distributed with a nozzle boom capable of applying the insecticide at the rate of one gallon per acre as a mist, with an average droplet size of 150 to 300 microns.

Spraying should take place during the early morning hours while the temperature is below 68 degrees F. and the wind velocity in the spray area is below six miles per hour.

TIMING AND SEQUENCE OF SPRAYING

Objective.--From observations on the progress of budworm larval development, to determine the timing of aerial insecticide and application.

Because of the extremely limited period when aerial insecticide can effectively control epidemic budworm infestations, it is most essential that the period of insecticide application be precisely determined. This period has been found to coincide with certain stages of budworm larval development; notably the 4th, 5th, and 6th instars. These instars, the periods between molts of the larvae, are six in number in a normal developing larvae. In a given budworm larval population, these instars will overlap somewhat so that the population may contain larvae of several instars at the same time; i.e., 2nd instar, 1 percent; 3rd instar, 24 percent; 4th instar, 46 percent; 5th instar, 27 percent; 6th instar, 2 percent (total, 100 percent).

Larval development may proceed more rapidly in some parts of the same spray block, in some blocks than in others, and in some control units than others. Development is usually faster on the warmer sites most frequently found at lower elevations, on south slopes, or in less dense stands.

Ordinarily, aerial spraying can commence in any spray block when an average of 50 percent or more of the larval population in the collections fall in the 5th and 6th instars. Usually less than 10 percent remains in the 3rd instar at this time.

In the current budworm control project the Budworm Development Checkers will provide the information upon which to base the above spray starting and termination dates. This they will do by making daily collections of budworm larvae from predetermined sampling plots strategically located throughout each control unit. The larvae will be classified by instars ocularly or from head capsule measurements. The percentages of larval sample in each instar will then be calculated. This procedure is probably one of the most critical and important phases of the project and much depends upon the thoroughness of the checkers.

Detailed Procedure.--The following section comprises the guidelines for the establishment of sampling plots, the collection and preservation of budworm larvae, larval instar determination, instar percentage calculations, and the estimating of beginning and ending dates of the spraying operations for each block.

BUDWORM DEVELOPMENT CHECKING PROCEDURE

A. Unit Biologists will attend a training school from May 28 through June 1 and will spend the next week on their respective control units carrying out the following duties in preparation for the arrival of the Larval Development Checkers on June 11:

1. Become familiar with the boundaries of the unit and the spray blocks.

2. Select a number of accessible locations scattered throughout the unit to be used as larval collection plots. These plots should be selected to sample

    a. a wide range of elevations
    b. typical infested timber types
    c. north and south exposures
    d. ridges and drainage bottoms
    e. foliage that can be reached from the ground.

3. Tag the center of all selected plots with a "Budworm Development Plot" tag. (See figure 1.).

4. Fill in all the information requested on the tag, including the elevation as determined with an altimeter or from a contour map.

5. Indicate plot number on tag from the following assigned number series:

a. White Sulphur Springs East Half Unit	100 to 199
b. White Sulphur Springs West Half Unit	200 to 299
c. Madison-Tobacco Root Unit	300 to 399
d. Pioneer Unit	400 to 499
e. Powell-Bitterroot Unit	500 to 599
f. Elk Horn-Crow Creek Unit	600 to 699

6. Fill out in triplicate form SBW-13 (Budworm Development Plot Data) for each plot. One copy will be kept by the Unit Biologist, the other copies will be given to the Checker and the Technical Director.

7. Arrange the plots into twice as many groups of 4 to 6 plots each as there are Budworm Development Checkers assigned to the unit, keeping in mind

    a. time required to travel to plots from unit headquarters
    b. ease with which larvae may be collected
    c. distance between plots
    d. capability of Checker assigned to plot.

8. Assign two groups of plots to each Development Checker with each group to be collected on alternate days.

9. Assign days that collections will be made on each group of plots to enable two Checkers to make their collections while traveling in the same truck.

10. Locate and number each plot accurately on a unit map.

B. Budworm Development Checkers will spend the week of June 11 in training on the control unit under their respective Unit Biologist. This training will be completed and collection plots assigned each Checker by June 15. Upon assignment of collection plots each Checker will proceed as follows:

1. Mark the location and number of each plot on his personal unit map.

2. Become familiar with the location of each plot.

3. Decide on the order of sampling the plots in each daily group and follow this order each collecting day.

4. Sample each group of plots on alternate days.

5. Leave unit headquarters by 10:00 a.m. each day to start larval collections after completing other assigned duties.

6. Upon arrival at the plot label the collecting vial (See figure 3.).

7. Collect budworm larvae from infested trees as follows:

   a. collect all larvae within 100 yards of the plot center
   b. cut a 15-inch twig from an infested tree after first placing a collecting cloth on the ground under it to catch any falling larvae
   c. open <u>all</u> foliage buds and collect any larvae within (early collections)
   d. collect all larvae and <u>pupae</u> on the twig (later collections)
   e. place all larvae and pupae collected in the vial and float them in collecting solution
   f. when <u>all</u> larvae on the twig have been collected move to another tree and cut another twig

g. repeat this procedure until the required number of larvae are obtained

h. additional twigs cut will be chosen at random and each should be from a separate infested tree.

8. At least 50 larvae will be collected from each plot each collection date from the time collections are started until 10 days prior to the beginning of spraying.

9. One hundred larvae will be collected from each plot during the 10-day period preceding spraying and during the spraying operation.

10. If the daily collections are completed before 3:00 p.m. scout the area and make observations and notes on the percentage of open buds before returning to unit headquarters.

11. Between 3:00 and 5:00 p.m. of the day larval collections are made or between 8:00 and 10:00 a.m. of the following day, the checker will examine the larvae collected at unit headquarters under the supervision of the Unit Biologist as follows:

a. place the larvae, from one plot at a time, in a petri dish and then separate them in watch glasses according to their instar classification

b. determine the proper instar by comparing the collected larvae with a set of sample larvae classified as to instar by head capsule measurements

c. count the larvae and determine the percentage in each instar.

12. Record these counts and percentages on form SBW-1 (Budworm Development Checkers Daily Report) and give this report to the Unit Biologist before 10:00 a.m. each day.

13. Return all larvae to the original collecting vials after counting and store these vials at unit headquarters.

C. After the collections of larvae have begun the Unit Biologist, in addition to supervising the collection and instar determination of the larvae, will keep the larval developmental records and make decisions as to start of spraying by using the following guide:

1. Upon receipt of the SBW-1 forms (Budworm Development Checkers Daily Report) from the Checkers he will compile the data from all plots and enter it in duplicate on form SBW-3 (Daily Budworm Larval Development Record).

2. One copy of form SBW-3 will be mailed to the Technical Director at the Forest Insect Laboratory, Federal Building, Missoula, Montana by noon of the day following the collections.

3. When 75 percent of the larvae on five or more spray blocks in the unit have entered into the 4th, 5th or 6th instar the Technical Director will be notified so that he can advise the Unit Supervisor and Project Director on form SBW-4 (Advance Notice of Spraying) that spraying operations can start in the unit in approximately 10 days.

4. When 50 percent or more of the larvae on five or more spray blocks in the unit enter into the 5th and 6th instars, the Technical Director and the Unit Biologist will jointly notify the Project Director and Unit Supervisor on form SBW-5 (Notice of Start of Spraying Operation) that certain spray blocks are released for spraying.

5. As 50 percent of the developing larvae in additional spray blocks enter the 5th and 6th instars, the Unit Biologist will release them for spraying on form SBW-6 (Notice of Spray Block Release). Copies of this release will be sent to the Unit Supervisor, Project Director and Technical Director.

6. When larval collections in any block show that 5 percent or more of the population has entered the pupal stage before spraying, the Technical Director should be immediately notified so he can consider with the Entomologist-in-Charge whether spraying on that block should be halted.

MEASURING SPRAY DEPOSITION

To determine if the insecticide dosage has been sufficient to cause adequate budworm larval mortality in a given area, three types of measurements will be used.

Prior to the spraying of each block, oil sensitive dye cards will be placed at four-chain intervals on a spray check line running at right angles to the spray swaths. Examination of these cards by the Unit Biologists after completion of the spraying will be made to give an indication of the amount of insecticide per acre reaching the ground in that area.

On lines where the cards show little or no spray deposited a second examination of the area for foliage "burning", caused by oil in the spray, will be employed. This examination will be made by the Spray Deposit Checker at the time he collects the dye cards.

In addition to searching for evidence of foliage burning the checker will also make an on-the-ground record of the presence or absence of dead larvae and larval webbing.

Failing to find sufficient evidence of spray deposition during these three examinations, a further effort of a more intense nature will be made to determine evidence of spray omission, the extent of the area missed, and the need for respraying. This examination will be made by the Unit Biologist or a Checker assigned to perform this function. Foliage burning and initial larval mortality measured in greater detail will form the basis of these determinations.

PROCEDURE FOR CHECKING OF AERIAL SPRAY DEPOSIT

The procedure to be followed for determining adequate insecticide deposition in a control area is as follows:

A. Prior to the start of spraying the Unit Supervisor and the Project Technical Director will collaborate in subdividing the control units into spray blocks. The following procedures are suggested for establishing blocks:

    1. Select natural boundaries that can be seen from the air, such as ridges, roads, parks, etc.
    2. Avoid the use of streams as boundaries whenever possible.
    3. Strive for blocks from 3,000 to 5,000 acres in size.
    4. Limit variations in elevations, if possible, to 2,000 feet.

5. Avoid the presence of north and south slopes of any great size in the same block.

6. Shape the block so that a good spray flight pattern may be made to cover it.

7. Locate all unit and block boundaries on a 2-inch-to-the-mile aerial photo mosaic at unit headquarters.

B. Prior to the start of spraying the Unit Biologist will select a starting point and bearing for the spray check line or lines to be located in each spray block. The procedure to be followed in the selection of these lines is as follows:

1. Whenever possible, select a starting point as close to a road as possible.

2. Select one or two locations for lines in each block.

3. Determine the number of lines after considering the manpower available and the length of lines.

4. Select a line bearing that will:

   a. not place the line too close to the unit boundary.

   b. be at right angles to the spray swaths.

   c. be in budworm host type.

   d. result in at least a mile of line.

5. Tag the starting point with a "Budworm Spray Check Line" tag (appendix figure 1).

6. Make detailed notes on the location of the starting point of the line.

7. Record on the photo mosaic the starting point, number, and approximate location of each line. Spray line numbers should be the same as the block numbers with a letter added if more than one line is located in the same block; i.e., 28A, 28B, and 28C.

C. After a spray block has been released for spraying, and within one to two days before spraying commences on the block, the spray deposit cards will be distributed in the following manner by the Spray Deposit Checkers:

1. The Unit Biologist will date and sign the "Released for Spraying" column on the Unit Progress Chart (appendix figure 4).

2. The Unit Supervisor will date and sign the "To be Sprayed" column on the Unit Progress Chart.

3. The Unit Biologist will then designate the date and checker for putting out the spray deposit cards in the "Put Out Spray Cards" column on the Unit Progress Chart.

4. The Spray Deposit Checker will then locate the start of the line on the photo mosaic and will receive directions from the Unit Biologist on how to reach the starting point.

5. On the date stated on the Unit Progress Chart, the Checker will travel to the start of the line and:

   a. attach his location string to the starting tag.
   b. while trailing the string, pace along the line on the bearing designated.
   c. place a spray deposit card on the ground at each four-chain interval along the line.
   d. select card locations not under heavy foliage.
   e. secure card to ground with large paper clip and nail.
   f. place serial numbered side of card face up.
   g. adjust paper clip to prevent curling of card.
   h. secure location string to the nail in each card so they can be located easily by the pickup Checker.
   i. keep a record of the serial numbers on the cards and their order on the line.

6. Upon returning to headquarters date the "Spray Cards Put Out" column and indicate the serial numbers of the cards used in the block.

D. After the spraying of the block has been completed and the Unit Supervisor has so indicated by dating and signing the "Spraying Completed" column of the Unit Progress Chart, the spray deposit line will be re-run in the following manner:

1. In the "Pickup Spray Cards" column of the Unit Progress Chart the Unit Biologist will indicate which Checker will re-run the line and the date on which it will be done.

2. The Checker will proceed to the line location tag and follow the string, retrieving the cards in order.

3. As each card is collected it will be given a brief examination for spray deposit spots.

4. If there are no oil deposit spots, or only a few, the Checker will make a further and immediate examination within a 50-foot radius of the card, as follows:

   a. make a check of foliage for evidence of oil burning.

   b. check for death webs on infested fir trees.

   c. look for dead or dying larvae on trees or ground.

   d. make notes of the above checks on the back of the spray card.

   e. collect a few leaves of wild rose, strawberry or other sprayed shrubs and tape them on the front of the card.

5. After the spray deposit cards have been collected, they should be returned to unit headquarters and given to the Unit Biologist.

6. In the "Cards Up" column of the Unit Progress Chart place the date the cards were collected on the appropriate line.

E. Upon receiving the cards from the Checker, the Unit Biologist will compare the spray droplet pattern with those of the "Standards for Estimating Airplane Spray Deposits on Oil-Sensitive Cards". If the comparison shows the deposit to be 0.20 pounds per acre or more for the block he will then proceed as follows:

   1. Complete form SEW 11 "Report of Satisfactory Spray Deposit" and send one copy of this form to the Unit Supervisor and keep one copy on file.

   2. Sign the column headed "Spraying of Block Satisfactory".

   3. File the spray deposit cards at unit headquarters and forward them to the Missoula Forest Insect Laboratory at the end of the project.

F. If the cards do not show a deposit of 0.20 pounds per acre, the Unit Biologist will try to determine from the notes taken by the Checker and the foliage samples attached to the cards if the area has been properly sprayed. If he determines the spraying to be satisfactory he will follow the procedure outlined under "E" above.

G. Should the Unit Biologist decide the block has not been properly covered by the spray he will then proceed as follows:

1. Appoint a checker to return to the block and make a further examination of the block. This Checker will determine the extent of the unsprayed area by observing foliage burning, dead and dying larvae and death webs.
2. The Unit Biologist will then complete form SBW 12 "Report of Unsatisfactory Spray Deposit" and send a copy to the Unit Supervisor and keep one copy on file. This Report will show what part of the block has not been properly covered with the spray.

H. If the Unit Supervisor orders the re-spraying of any block or portion thereof, the portion to be resprayed will be treated as a new block and the entire "Procedure for Checking of Aerial Spray Deposit" will be repeated.

DETERMINING BUDWORM MORTALITY

One of the major technical responsibilities of the Missoula Forest Insect Laboratory is the determining of the effectiveness of the control effort. So that the mortality directly attributable to the aerial spraying can be completed, it will be necessary to take a larval population sample throughout each control unit immediately prior to and 10 days after the spraying of each block. The comparison of living larval populations before and after spraying will provide a fairly accurate estimate of the percentage of mortality occurring in an area. It is recognized that a small amount of larval mortality at this time may be caused by parasites, predators or disease.

The mortality estimate computed by this method should show if the project has reduced the budworm population to an endemic level.

PROCEDURE FOR CHECKING BUDWORM MORTALITY

A budworm population count made immediately prior to and 10 days after a block has been sprayed will determine the percentage of larval mortality caused by the aerial spraying of the DDT in oil. While it may not be possible to establish the mortality caused by the insecticide in every spray block, an attempt should be made to sample as many blocks as possible. The following procedure will be followed in establishing the insecticide-caused mortality:

A. Pre-spray budworm population count:

1. In each block the Unit Biologist will select a starting point for a mortality sampling line. This starting point will be known as a Budworm Population Station .
2. Tag this station with a "Budworm Population Station" tag (see figure 5).
3. Fill out form SBW 14 "Budworm Population Station Data", giving specific directions on how the station may be located and the bearing of the line to the 10 population plots from this station.
4. Locate and number each station on the unit's aerial photo mosaic.
5. One or two days prior to the start of spraying on the block a checker will be assigned by the Unit Biologist to make the population count.

6. The assigned Checker will then proceed to make the count as follows:

   a. At the starting station clip two 15-inch branches from a budworm infested tree. Select branches from the shaded side of the tree and from the extreme outer tip of the limbs.

   b. Clip the branches over a collecting cloth to catch any falling larvae and place all larvae and pupae in a collecting vial. Be sure to open all tree buds and to collect any small larvae within.

   c. This procedure will be repeated at a total of 10 sampling plots on a line extending from the Budworm Population Station. The Population Station will be the first sampling plot on each line.

   d. The sampling line will extend from the Population Station on the bearing given on form SBW 14 "Budworm Population Station Data".

   e. Each plot will be 5 chains (330 feet) apart, if the distances are paced; or 0.2 miles apart, if established along roads by automobile odometer readings.

   f. All larvae collected from the 10 plots will be placed in one vial. Label this vial with the block number, station number, date, and Checker (see figure 6).

   g. Upon returning to unit headquarters the checker will count the larvae and pupae collected and record the totals on form SBW 18 "Budworm Population Count".

7. If for any reason the block is not sprayed within five days of the pre-spray count, the line should be recounted immediately prior to spraying.

B. Post-spray budworm population count:

1. Seven to ten days after the final spraying of a block the Unit Biologist will assign a Checker to make the post-spray population count. Where it is practical the same checker who made the pre-spray count should be assigned for this job.

2. The Checker should repeat the same procedure used in the pre-spray count except that four 15-inch branches will be clipped at each station and empty pupal cases will be collected in addition to pupae.

3. All larvae, pupae and pupal cases from the 10 plots on the sampling line will be placed in a properly labeled vial.

4. Upon returning to unit headquarters counts will be made and totals entered in the proper columns on form SBW 18 "Budworm Population Count".

C. When the pre-spray and post-spray counts on a spray block have been completed, one copy of form SBW 18 should be mailed to the Technical Director at the Missoula Forest Insect Laboratory and one copy should be kept on file by the Unit Biologist.

PERSONNEL REQUIREMENTS

The following personnel will be required to manage the technical responsibilities of the Intermountain Station.

6 Unit Biologists

All Biologists will report to the Missoula Forest Insect Laboratory at 8:00 a.m. June 6. A Unit Biologist will be assigned to each control unit to function in this capacity until the end of spraying, probably late in July. They may be required to work a 56-hour work week immediately prior to and through the spraying period and a 48-hour week the remainder of the time, as required, at current overtime pay rates.

28 Budworm Development and Mortality Checkers

Checkers will be assigned to control units as indicated below and will report to their unit headquarters at 8:00 a.m. on June 11. They will be employed in this capacity probably until late in July, as follows:

- 4 Checkers on the White Sulphur Springs, West Half Unit
- 4 Checkers on the White Sulphur Springs, East Half Unit
- 6 Checkers on the Powell-Bitterroot Unit
- 6 Checkers on the Madison-Tobacco Root Unit
- 4 Checkers on the Pioneer Unit
- 4 Checkers on the Elkhorn-Crow Creek Unit

They will be required to work, and be paid for, the same overtime hours as the Unit Biologists.

21 Spray Deposit Checkers

Spray Deposit Checkers are required for a short period while the units are being sprayed. These checkers should report to the unit headquarters a week before the spraying is to start on the first spray block. They will be employed until two days after the spraying is completed on the unit. Checkers will be required to work a 56-hour work week during this period. One Checker will be required for each aircraft of 400-gallon spray capacity or more, and one checker for every two aircraft of a lesser capacity.

TRANSPORTATION REQUIREMENTS

Transportation for the Entomologist-in-Charge and the Technical Director will be furnished by the Intermountain Station. The additional technical men assigned to the budworm project will be supplied with transportation by Forest Service Region One, probably through each of the national forests included in the control project. One vehicle will be required for each two checkers, preferably a ½-ton pickup truck meeting Forest Service safety standards.

The number of vehicles required by the Station from Forest Service Region One, together with the time and place of need, is as follows:

Forest Insect Laboratory, Missoula, Montana:

6 Vehicles for Unit Biologists from June 6 through August 1

White Sulphur Ranger Station, White Sulphur Springs, Montana:

4 Vehicles for Development Checkers from June 11 through August 1

4 Vehicles for Spray Deposit Checkers through spraying period

Powell Ranger Station, Idaho:

2 Vehicles for Development Checkers from June 11 through August 1

2 Vehicles for Spray Deposit Checkers through spraying period

Sula Ranger Station, Sula, Montana:

1 Vehicle for Development Checkers from June 11 through August 1

1 Vehicle for Spray Deposit Checker through spraying period

Ennis Ranger Station, Ennis, Montana:

3 Vehicles for Development Checkers from June 11 through August 1

2 Vehicles for Spray Deposit Checkers through the spraying period

Dillon Ranger Station, Dillon, Montana:

2 Vehicles for Development Checkers from June 11 through August 1

2 Vehicles for Spray Deposit Checkers through spraying period

Helena Ranger Station, Helena, Montana:

2 Vehicles for Development Checkers from June 11 through August 1

2 Vehicles for Spray Deposit Checkers through spraying period

In recapitulation, a total of 33 vehicles will be required on the following dates:

6 Vehicles June 6 through August 1

14 Vehicles June 11 through August 1

13 Vehicles through the spraying period[1/]

1/ Probably between June 20 and July 20

EQUIPMENT NEEDS

UNIT BIOLOGISTS

Each Unit Biologist will be issued the following items of equipment and it will be his responsibility to see that they are kept in proper condition and returned to the Technical Director at the end of the project.

Quantity	Item
1	collecting bag
1	dissecting set
1	tatum, 8 x 10
1 gross	vials, opticlear, 30 x 80 mm
1	cloth, collecting 3 x 3 feet
1	shears, pruning
1	compass, pocket
1	first aid kit, pocket
1	register, tally
150	tags, tree marking
1 gal.	alcohol (70%)
1	altimeter
1	larval instar standard set
1	larval sorting dish set
3 cones	string, location marking
1	lens, hand 12x
100	labels, vial

BUDWORM DEVELOPMENT AND MORTALITY CHECKERS

Each Checker will be issued the following items of equipment and it will be his responsibility to see that they are kept in proper condition and returned to the Unit Biologist at the end of the project.

Quantity	Item
1	collecting bag
1	dissecting set
1	tatum 6 x 8
1 gross	vials, opticlear 30 x 80 mm
1	cloth, collecting 3 x 3 feet
1	shears, pruning
1	compass, pocket
1	first aid kit, pocket
50	tags, tree marking
1 qt.	alcohol (70%)
1	larval instar standard set
1	larval sorting dish set
1	lens, hand 3x
100	labels, vial

SPRAY DEPOSIT CHECKERS

Each Checker will be issued the following items of equipment and it will be his responsibility to see that they are kept in proper condition and returned to the Unit Biologist at the end of the spray project.

Quantity	Item
1	tatum
1	compass, pocket
1	first aid kit, pocket
3 cones	string, location marking
100	tags
10	spray deposit cards (50 to each set)
3 rolls	tape, Scotch
1	apron, carpenter's

SUMMARY OF EQUIPMENT NEEDS

Quantity	Item
34	collecting bags
34	dissecting sets
34	tatums, 8 x 10 inches
24	tatums, 6 x 8 inches
350 doz.	vials, opticlear, 30 x 80 mm
34	cloths, collecting, 3 x 3 feet
34	shears, pruning
60	compasses, pocket
60	first aid kits, pocket
6	registers, tally
5000	tags, tree marking
13 gals.	alcohol (70%)
6	altimeters
34	larval instar standard sets
34	petri dishes
175	watch glasses
100 cones	string
6	lens, hand 12 x
32	lens, hand 3 x
5000	labels, vial
6	jugs, 1 gal.
32	jugs, 1 qt.
75 rolls	tape, Scotch small
1	stamp, rubber for spray line cards
1	stamp, rubber for development plots
1	stamp, rubber for vial labels
15,000	spray deposit cards

SUMMARY OF EQUIPMENT NEEDS (Cont.)

Quantity	Item
10	maps, White Sulphur Spgs. Unit ½-inch scale
18	maps, White Sulphur Spgs. Unit
5	maps, Powell Unit ½-inch scale
10	maps, Powell Unit ¼-inch scale
5	maps, Bitterroot Unit ½-inch scale
3	maps, Bitterroot Unit ¼-inch scale
5	maps, Madison-Tobacco Root ½-inch scale
12	maps, Madison-Tobacco Root ¼-inch scale
5	maps, Pioneer-Beaverhead ½-inch scale
14	maps, Pioneer-Beaverhead ¼-inch scale
5	maps, Helena Unit ½-inch scale
10	maps, Helena Unit ¼-inch scale
2	parachutes
2	bags, parachute
60	notebooks, 3 x 5 USFS
1	lamp, black light
6	aprons, carpenter's

APPENDIX

SPRUCE BUDWORM

Choristoneura fumiferana (Clem.)

1. Severely defoliated Douglas fir forest (note grayish cast).
2. Budworm defoliated tips of Douglas fir twigs.
3. Douglas fir twig showing larval webbing, pupae, and damage.
4. Larvae, pupae, empty pupal cases, and adult moths.

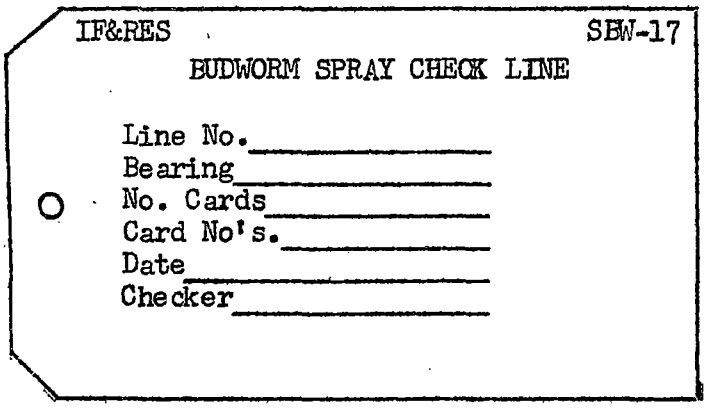


Figure 1.--Sample budworm spray check line marker

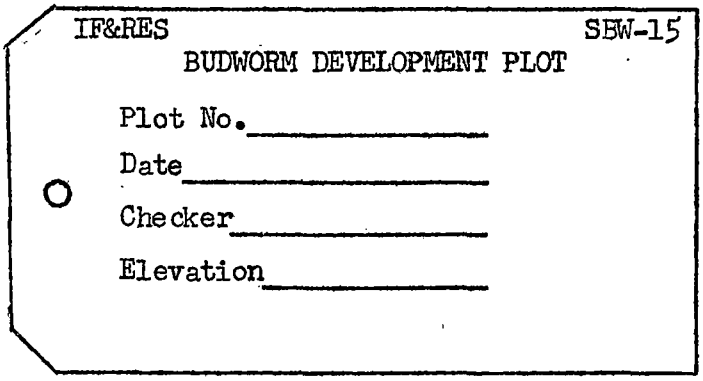


Figure 2.--Budworm development plot marker

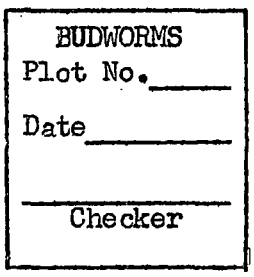


Figure 3.--Budworm vial label

Figure 4.--Sample of chart for use by Unit Biologist in recording progress of project on their unit

Intermountain Forest and Range Experiment Station SBW-10

1956 SPRUCE BUDWORM PROJECT UNIT PROGRESS

BLOCK NO.	BLOCK NAME	ACRES	INSECTICIDE, gallons	RELEASED FOR SPRAYING		TO BE SPRAYED	
				Date	Unit Biologist	Date	Unit Supervisor
		Acres in block	Number of gallons of insecticide sprayed in block	Date released for spraying	Signature of Unit Biologist	Date to be sprayed	Signature of Unit Supervisor or Assistant

PUT OUT SPRAY CARDS		SPRAY CARDS PUT OUT			SPRAYING COMPLETED		PILOT	PICK-UP SPRAY CARDS	
Date	Checker	Date	Numbers	Checker	Date	Unit Supervisor		Date	Checker
Date and name of checker who will put out spray cards		Date cards were put out	Number of the cards that were put out	Signature of checker	Date that spraying was finished on block	Signature of Unit Supervisor or assistant	Name of pilot who sprayed block	Date cards are to be picked-up	Name of checker who will pick-up cards

SPRAYING OF BLOCK SATISFACTORY	
Unit Biologist	Unit Supervisor
To be signed by the Unit Biologist and the Unit Supervisor when they are satisfied the block has been properly sprayed	

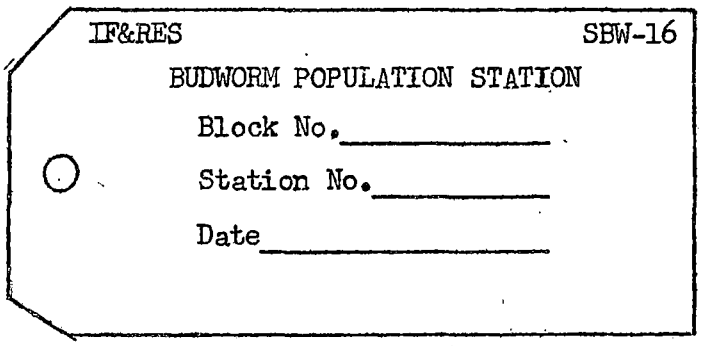


Figure 5.--Budworm Population Station Tag

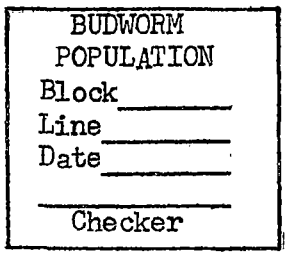


Figure 6.--Vial Label for Population Count

Intermountain Forest & Range Experiment Station
Missoula Forest Insect Laboratory

Form SBW-1

Spruce Budworm Control Project

BUDWORM DEVELOPMENT CHECKERS DAILY REPORT

Unit _____

Date of collection _____

Collector _____

Station No.	Stage of larval development, by instars										Pupae		No. Larvae Collected
	2nd		3rd		4th		5th		6th				
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	
Totals													

One copy of the report will be filled out completely by the Development Checker each day that larval collections are made. It will be given to the Unit Biologist by 10:00 a.m. of the day following larval collections.

Intermountain Forest & Range Experiment Station
Missoula Forest Insect Laboratory

Form SBW-3

Spruce Budworm Control Project

DAILY BUDWORM LARVAL DEVELOPMENT RECORD

Unit _____

Date of collections _____

Station No.	Larval instars 2nd		3rd		4th		5th		6th		Pupae		No. Larvae Collected	Collector
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%		
Totals														

Weather Report

Air temperatures: maximum___; Minimum___. Precipitation___inches.

Remarks- _____

_____

Approved _____
Unit Biologist

1 copy each to:
Unit Biologist
Technical Director

Intermountain Forest & Range Experiment Station
Missoula Forest Insect Laboratory

Form SBW-4

Spruce Budworm Control Project

ADVANCE NOTICE OF SPRAYING

Spruce budworm larval populations will be ready for spraying on some blocks on the _____ Control Unit on or about _____ (day), _____ (date) if seasonal weather conditions prevail.

Approved: _____
Technical Director

Date: _____

1 copy each to:

Unit Supervisor
Unit Biologist
Project Director
Entomologist-in-Charge

Intermountain Forest & Range Experiment Station
Missoula Forest Insect Laboratory

Form SBW-5

Spruce Budworm Control Project

NOTICE OF START OF SPRAYING OPERATIONS

Spruce budworm larval populations on the _____ Control Unit have developed to a stage where the spray blocks with larvae in the most advanced stages will be released for spraying on

_____, _____,
day date

Approved: _____
Unit Biologist

Approved: _____
Technical Director

Date: _____

1 copy each to:

Project Director
Unit Supervisor
Entomologist-in-Charge
Unit Biologist
Technical Director

Intermountain Forest & Range Experiment Station
Missoula Forest Insect Laboratory

Form SBW-6

Spruce Budworm Control Project

NOTICE OF SPRAY BLOCK RELEASE

Spruce budworm larval populations will be ready for spraying on the following blocks in the _____ Control Unit on _____ (day), _____ (date):

Block No.	Block Name

Approved: _____
Unit Biologist

Date: _____

1 copy each to:
- Unit Supervisor
- Project Director
- Entomologist-in-Charge
- Unit Biologist

Intermountain Forest and Range Experiment Station
Missoula Forest Insect Laboratory

Form SBW 11

Spruce Budworm Control Project

REPORT OF SATISFACTORY SPRAY DEPOSIT

Evaluation of the spray deposited on the oil-sensitive dye cards collected from spray block:

No._____ Name_____

shows the average spray deposited to be

_____ gallons per acre.

From examination of the cards and other observations, this block is believed to have been adequately treated with insecticide.

Approved:_____
Unit Biologist

Date_____

Notes_____

_____

_____

1 copy each to:

Unit Supervisor
Unit Biologist

Intermountain Forest & Range Experiment Station
Missoula Forest Insect Laboratory

Form SBW 12

Spruce Budworm Control Project

REPORT OF UNSATISFACTORY SPRAY DEPOSIT

Evaluation of the spray deposited on the oil-sensitive dye cards collected from spray block

No._____ Name_____

shows the average spray deposit to be

_____ gallons per acre.

From examination of the cards and other observations, this block is believed to have been inadequately treated with insecticide.

To achieve adequate budworm control, it is recommended that re-spraying be ordered for_____ acres of this block located as follows:_____

_____

_____

Approved:_____
Unit Biologist

Date_____

1 copy each to:
Unit Supervisor
Unit Biologist

Intermountain Forest & Range Experiment Station
Missoula Forest Insect Laboratory

Form SBW-13

Plot No.

Spruce Budworm Control Project

BUDWORM DEVELOPMENT PLOT DATA

Collection Plot Number _____

Location:

Control Unit _____

Spray Block No. _____

Spray Block Name _____

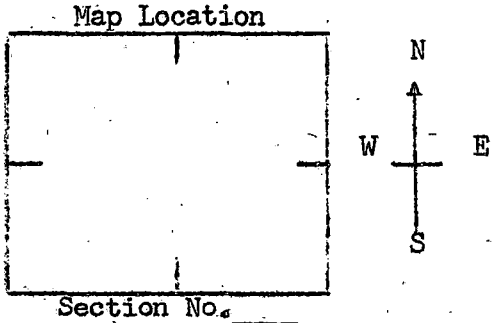
Township _____; Range _____; Section _____.

Travel Directions _____

_____

_____

Map Location



Section No. ____

Exposure:
Topography; Ridge, Creek bed, Flat.
Exposure; N, S, E, W.

Stand Description:
Timber Type; DF, LPP, WF, S, PP, AF.
Average overstory d.b.h., 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46, 48
Average understory d.b.h., 2, 4, 6, 8, 10, 12, 14, 16, 18
Density of stand; Light, Medium, Heavy, Very Heavy.

1 copy each to:
Unit Biologist
Technical Director
Development Checker

Intermountain Forest & Range Experiment Station
Missoula Forest Insect Laboratory

Form SBW 14

STATION NUMBER

Spruce Budworm Control Project

BUDWORM POPULATION STATION DATA

Control Unit _____

Spray Block _____

Spray Block No. _____

Elevation _____

Plot Line Bearing _____

Pre-spray Checker _____

Date Pre-spray Check _____

Post-spray Checker _____

Date Post-spray Check _____

Location - Township _____

Range _____

Section _____

Direction to Station (Detailed) _____

_____

_____

_____

1 copy each to:
Technical Director
Unit Biologist
Pre-spray Checker
Post-spray Checker

Intermountain Forest & Range Experiment Station
Missoula Forest Insect Laboratory

Form SBW 18

Spruce Budworm Control Project

BUDWORM POPULATION COUNTS

Control Unit_____ Spray Block No._____

BEFORE SPRAYING							AFTER SPRAYING				
Date Examined_____ Collector_____							Date Examined____ Collector_____				
Plot No.	Tree Sp.	Dist. Next Sample	No. of Branches	Branch Length	Number of Live Larvae	Number of Live Pupae	No. of Branches*	Branch Length	Number of Live Larvae	Number of Live Pupae	Number of Emerged Pupae
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
Total	-	-		-				-			
Total	-	-		-				-			

* The number of branches examined After Spraying will be twice the number examined Before Spraying.

Percent Mortality = $\left[\frac{\text{(Pre-Spray Count X 2)} - \text{Post-Spray Count}}{\text{(Pre-Spray Count X 2)}}\right] \times 100 =$ _____ %

1 copy each to:
Technical Director
Unit Biologist